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INSIGHT SEMINAR: Bio-inspired strategies for the design of electrocatalysts for NOx to ammonia reduction

VICTOR MOUGEL

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12:00 to 13:00
Elements Room

BIO:

Victor Mougel is currently serving as a tenure track assistant professor of Inorganic Chemistry in the Department of Chemistry and Applied Biosciences at ETH Zürich. Hi academic journey began with a Bachelor's and Master's degree in Chemistry from the ENS o Lyon. He pursued his doctoral studies at the University of Grenoble, working under th guidance of Prof. Marinella Mazzanti. After completing his PhD, he joined ETH Zürich as n ETH Fellow, in the group of Prof. Christophe Coperet. In 2016, he started his independe t career as a CNRS associate researcher at College de France in Paris, before returning to E

H Zurich in December 2018. Currently, his research interests revolve around t
e electrochemical activation of small molecules, drawing inspiration from enzymatic systems
n a bio-inspired approac

ABSTRACT:

Enzymatic systems have evolved complex strategies to maximize the efficiency and product selectivity in small molecule activation. Besides unique active sites containing, by definition, earth-abundant elements, enzymes further control catalytic activity through second-sphere interactions and a fine control of electron transfer chains.

In this talk, we will be introducing a series of bio-inspired strategies for the design of electrocatalytic systems for NOx conversion to ammonia. Inspired by molybdenum- and iron-dependent nitrate reductases, we first explored Fe-substituted Mo2CTx MXenes, aiming at mimicking enzymatic Fe and Mo active sites.1 Our findings revealed that Fe incorporation promotes the formation of surface oxygen vacancies, which act as key sites for nitrate activation. Recognizing the importance of oxygen vacancies in catalytic performance, we developed a molybdenum oxide material presenting a large number of oxygen vacancies, formed through high-current-density deposition on dendritic nickel foam.2 This approach enabled us to achieve exceptional catalytic stability for NO3RR over 3100 hours at high current densities. Motivated by the unprecedented activities observed with these dendritic materials, we explored their application for NOx reduction, and demonstrated that, using them in a MEA-type electrolyzer allowed unique performances for the reduction of nitrogen oxide to ammonia, reaching Faradaic efficiencies close to unity and enabled benchmark single pass NO conversion over 93%.3

Last, by optimizing catalyst design with the thermodynamic constraints of nitrate electroreduction in mind, we developed a highly stable electrocatalyst capable of sustaining high ammonia production rates even in strongly alkaline environments. Finally, we explored how these insights into selective NO?RR pathways could be leveraged beyond ammonia synthesis. This led us to design a tandem electrocatalytic strategy for the efficient synthesis of glycine from oxalic acid and nitrate, demonstrating unprecedented faradaic efficiencies for C-N bond formation.4

Hosted by: Prof. Dr. F. Pelayo Garcia de Arquer